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UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

THE BIOLOGY OF THE ORANGE TORTRIX, ARGYROTAENIA
CITRANA (FERNALD) ON MONTEREY PINE
(Lepidoptera-Tortricidae)

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The Biology of the Orange Tortrix, Argyrotaenia (Tortrix)
citrana (Fernald) on Monterey Pine.
(Lepidoptera, Tortricidae)

INTRODUCTION

The orange tortrix, Argyrotaenia citrana (Fernald) is a native pest throughout ^{coastal} California on a number of plant hosts, the larvae webbing and feeding on the leaves. The larvae do their most serious damage, however, to the fruit of the orange by burrowing through the rind and thus furnishing a source of infection for fungi or causing a premature dropping of the fruit. (1)

During the summer of 1934 the author was attracted to larvae seriously defoliating several young, potted Monterey pines, Pinus radiata Don. at the laboratory of the Forest Insect Laboratory, Berkeley, California. Some adults were reared from pupae collected on the trees and determined by Mr. H. H. Keifer of the State Dept. of Agriculture as Argyrotaenia citrana (Fernald). As no record could be found of this species attacking Monterey pine and as no life history of this species was available on this host, work was begun immediately.

The life history studies in this paper were worked out under laboratory conditions and supplementary studies made under natural outdoor California conditions. Larvae were reared in small stender dishes on small slips of foliage, frequent changes of foliage being necessary. Moisture was provided by a ring of moistened blotting paper or a moistened porous soil mixture consisting of soil, plaster of paris, and lamp black. It was found advisable to add very little moisture as fungus growth would soon set in if the humidity was too high. Data for the life history studies in this report was based upon the successful rearing of fifteen adults through the complete life history, and supplemented with observations on a great many more individuals.

The author is very greatly indebted to Mr. J. M. Miller of the U. S. Bureau of Entomology for suggestions during the preparation of this report and for critically reading the manuscript, and to Professor E. C. Essig, of the University of California, who kindly read the manuscript. Professor H. J. Quayle, of the Citrus Experiment Station at Riverside, furnished information concerning this insect on the orange in southern California. Miss Pauline Schulthess kindly carried on rearing records while the author was in the field. Mr. J. E. Patterson, of the Bureau of Entomology, aided materially in the photographic work and is responsible for the life history plate.

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(1) H. J. Quayle, Biology and Control of Citrus Insects and Mites, University of California Agriculture Experiment Station, Bulletin 542, pp. 61-62, 1932

Argyrotaenia citrana (Fernald)

DISTRIBUTION AND HOSTS

Argyrotaenia citrana (Fernald), the orange tortrix, is found throughout California attacking a variety of hosts. H. S. Essig (1) lists the following hosts as being normally attacked: goldenrod, oak, black walnut, and willow and have worked over to acacia, apricot, asparagus, begonia, cineraria, Job's tears, eucalyptus, ferns, geraniums, Jerusalem cherry, lantana, lavender, orange, pentas, rose and wandering Jew.

With this wide range of hosts it is not particularly unusual to find this species working over to pine, and perhaps there is wider host choice than is indicated in the above list.

IMAGO

The imago is a fawn or gray colored moth with a wing expanse of 12-22 mm, the fore wings crossed with an oblique darker band. The females are unusually larger than the males. (See Plate I)

The original description by Fernald is as follows: (2)

Expanse of wings, 20 mm. Head, palpi, thorax and fore wings, cinnamon brown, varying somewhat in different specimens. The palpi are pectinate, compressed laterally, and the last joint is short and blunt. The thorax has a very small tuft behind which is tipped with ferruginous. The fore wings are crossed by an oblique, dark brown band which arises from the middle of the costa and the outer edge ends near the anal angle below the subcostal more or less completely. A triangular brown spot rests on the outer fourth of the costa. The surface of the wing, when viewed obliquely appears to be crossed by a large series of irregular stripes of lead colored scales. The terminal line is dark brown when present, and the fringes are cinnamon brown. Hind wings white, tinged with steel gray on the anal portion. Underside of the body and wings, pale yellowish.

Bred from orange in California, by Mr. Coquillett. I have also seen one from leaves of Solidago and one from willow, all from California."

EGG STAGE

Under natural conditions the eggs are deposited in masses, glued to a single needle or between two needles. Adult females placed in outdoor screen cages laid eggs usually along the metal reinforcements of the cages, and those placed in petri dishes deposited them on the glass top. They seem to prefer a smooth surface of egg deposition. The size of the egg varies, as they are laid in an overlapping manner like fish scales, but average

(1) H. S. Essig, Insects of Western North America, p. 737, 1929.

(2) C. H. Fernald, North American Microlepidoptera, Ent. Amer.

5:18, 1899

about 1 mm. long by .5 m. wide, are yellowish in color and have the surface distinctly netlike in appearance. The number of eggs in a mass varies from 7 to 65 with the average around 25. (See Plate II).

LARVAL INSTARS

Five larval instars are found in this species, with four moults occurring.

First instar larva: Length 1.75 mm., extended; general color a pale yellowish-green; head and prothoracic shield, brown; body clothed with moderately long, colorless setae; four pairs of prolegs and an anal pair of prolegs, and 3 pairs of true legs, concolorous with body; move rapidly and suspend themselves on a thread when disturbed.

The length of the first instar was found to vary from 6-14 days with an average of 9.35 days (Table 2).

Second instar larva: Length 3.5 mm; color pale yellowish-green; setae on body arising from small black pointed tubercles; anal plate with long setae; body tapering slightly anteriorly and posteriorly; head and prothoracic shield brown; eyes prominent, black; legs as in previous instar, concolorous with body.

The second instar was found to range in time from 5-9 days with an average of 7.39 days (Table 2).

Third instar larva: Length 5 mm; body yellowish-green; head and shield light brown; body with setae arising from colorless tubercles, the tubercles later becoming dark; anal plate with long projecting hairs, darker than body and with darker spottings; four pairs of prolegs on segments, 6, 7, 8, 9, concolorous with body; three pairs of true legs, darker than body.

The duration of the third instar was found to be from 5-8 days and the average, 5.8 days (Table 2).

Fourth instar larva: Length 9 mm.; body a pine-needle green, set with colorless, raised tubercles from which arise long light colored tubercles; anal plate with long spines and marked with dark spots; head pale brown with darker markings; prothoracic shield brown; prolegs as in previous moult, concolorous with body; 3 pairs of true legs with apical segments black marked.

The fourth instar was found to last from 4-14 days with an average of 7.5 days (Table 2).

Fifth instar larva: Length 11 mm., extended; body green, with indication of dorsal dark line and two addorsal lines, one on each side (1) body set with light colored tubercles with projecting setae; head and shield

(1) The dark dorsal line appears to be due to the transparency of the skin allowing the dorsal vessel to show through, rather than to any pigmentation of the skin.

green to a light brown; legs concolorous with body, arrangement the same as in the previous instar (See Plate II).

The duration of the fifth instar was 4 to 12 days with an average of 8.18 days (Table 2).

PUPAL STAGE

The pupa is a dark chestnut brown, 8-9 mm. in length, with the abdominal segments set with two rows of projecting spines. The pupal period was found to last from 7 to 12 days with an average of 9.25 days (Table 3). A very fine silk cocoon surrounds the pupa which may be found woven in between the needles, or attached almost any place along the smaller twigs.

HABITS AND BIOLOGY

Adult: The adults of Argyrotaenia citrana (Fernald) are very inactive during the day but become active toward dusk and at night. When at rest the wings are folded backwards over the body in regular tortricid style. In copulation the male and female face in opposite directions, the tips of the abdomens together and the female firmly clasped by the male. They remain in coitu often for several hours. Eggs are deposited for 1 to 2 days after mating. Adults were kept alive in outdoor cages for several weeks without feeding.

Egg: Individual gravid females isolated after copulation in petri dishes or in outdoor screen cages deposited from 25 to 245 eggs each, (See Table 1).

The length of the incubation period under laboratory conditions ranged from 8 to 13 days with an average of 10.55 days (Table 3).

Larval: About 24 hours before emergence of larvae from the eggs, the black head capsule of the larvae can be seen through the egg, or they

TABLE 2
Deposition of eggs by isolated gravid females of
Argyrotaenia citrana (Fernald)

Rearing No.	Date Laid	No. Eggs
2 RAO		
female placed in	Feb. 3	45
petri dish, Feb. 4.	6	20
	7	20
2 ACP - female placed in	11	20, 13
screen cage, Feb. 10	12	30, 52
	13	20
3 RAO - female placed in petri	14	22, 16, 63, 25, 17
dish, Feb. 11.	16	13
	17	15, 22
		7

become "black spotted". In emerging from the egg the larvae cuts a hole through the outside membrane with large mandibles. The opening is enlarged by turning the head from side to side during the operation. The entire process of cutting the opening through to the outside takes about 9 minutes. With the opening made, the larvae pulls itself out and immediately sets out to see the world. Newly emerged larvae are very active and disperse very quickly. Feeding is usually begun near the base of the bundle or under a bud bract where the larva makes a thin protective webbing. The young larvae usually take up a mining habit during the first two instars by mining out the interior of the needles at the base of the needle under the sheath. Other larvae, however, are content to work as external feeders on the needles, although always protecting themselves with a veil of silk webbing. As the larvae grow they become more and more external feeders on the young tender needles, and abandon their mining habits. In moulting, a thin protecting mat of silk is laid down. A larvae when mature seeks a well protected back between the needles, along the very small twigs, or even along the stem of the young tree, to pupate and makes a thin silk cocoon about itself. Feeding stops at this time, and the larvae becomes yellowish and wrinkled.

TABLE 2

Length of larval instars of Argyrotaenia citrana (Fern.) of Spring Brood Under Laboratory Conditions.

Instar	Length of instar		
	Minimum-Days	Maximum-Days	Average-Days
First	6	16	9.55
Second	5	9	7.39
Third	5	8	5.80
Fourth	4	14	7.50
Fifth	4	12	8.18

TABLE 3

Length of Egg and Pupal Stages of Argyrotaenia citrana (Fernald) of Spring Brood Under Laboratory Conditions.

Stage	Length of stage		
	Minimum-Days	Maximum-Days	Average-Days
Egg	8	13	10.55
Pupal	7	13	9.86

* A total of 201 eggs were laid between 10:00 P.M. on Feb. 13, and 8:00 A.M., Feb. 14, or in 10 hours.

TEMPERATURE RELATIONS

As no thermograph was available temperature readings were taken three times daily, 8 A.M., 12 P.M., and 4 P.M. inside the laboratory and outside. Such readings do not give a true picture of temperatures but suffice for the purposes of this study.

Temperature was correlated in a general way with the incubation period inside the laboratory and outside under natural conditions just to get some idea as to the times involved. It was found that it took two to four times as long for the eggs to develop under natural conditions as it did in the laboratory.

PARASITES

No parasites were reared from any material during these studies. Fungus attack was serious in life history rearing under laboratory conditions, when the humidity was high.

GENERATIONS

There are indications of at least two generations a year with some larval broods of the second generation overwintering and completing their development the following year. The broods on the Monterey pines studied were very irregular, as in January, 1935, second to fourth instar larvae were found upon the trees. This indicates that this species overwinters as larvae in various stages of development, the mature larvae quickly pupating in the spring and some adults emerging and laying eggs for the spring generation. At this time if temperature relations are favorable it is possible for a new brood to get under way. The typical case, however, would appear to be where development is stopped due to lower temperatures, as was the case in the spring of 1935, where the egg stage lasted from 29 to 44 days in comparison with a 10 day average at laboratory temperatures and conditions. The second peak seems to occur along toward the end of June to about the tenth of July, but the interrelationships of the broods make it difficult to separate the spring and fall broods.

TABLE 4

A Comparison of Laboratory and Outside Temperatures in Degrees F.
During Life History Studies of *Agryotaenia citrana* (Fernald)

Period	Temperature Average					
	Laboratory			Outside		
	8 A.M.-12 P.M.-4 P.M.			8 A.M.-12 P.M.-4 P.M.		
February 5, to 28	66.08	70.00	70.90	53.60	60.77	61.45
March 1, " 31	66.21	71.25	76.00	51.21	59.10	59.82

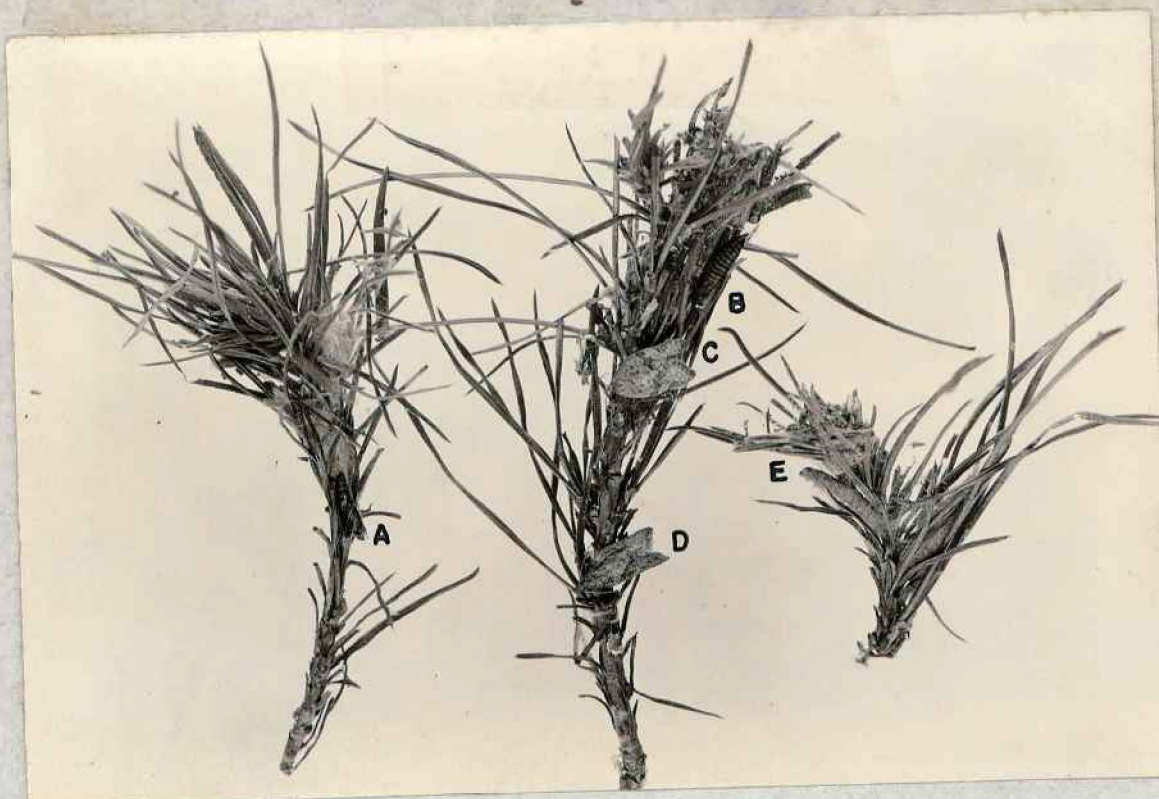
SUMMARY

The orange tortrix, Argyrotaenia citrana (Fernald), a native insect of California attacking a wide variety of hosts was found in Berkeley attacking a new host, Monterey pine, Pinus radiata Don. It was doing considerable damage to young potted trees by defoliation to the terminal and lateral buds. This species was found to have five instars and four molts, with an average life cycle of about 54 days. Females were found to deposit from 50 to 245 eggs on the pine foliage during a life time. The life history in the spring under natural conditions is at least two weeks slower than the results obtained under laboratory conditions. There are at least two generations a year, with the fall brood larvae overwintering as larvae in all instars. Further studies should indicate in more detail the brood relationships.

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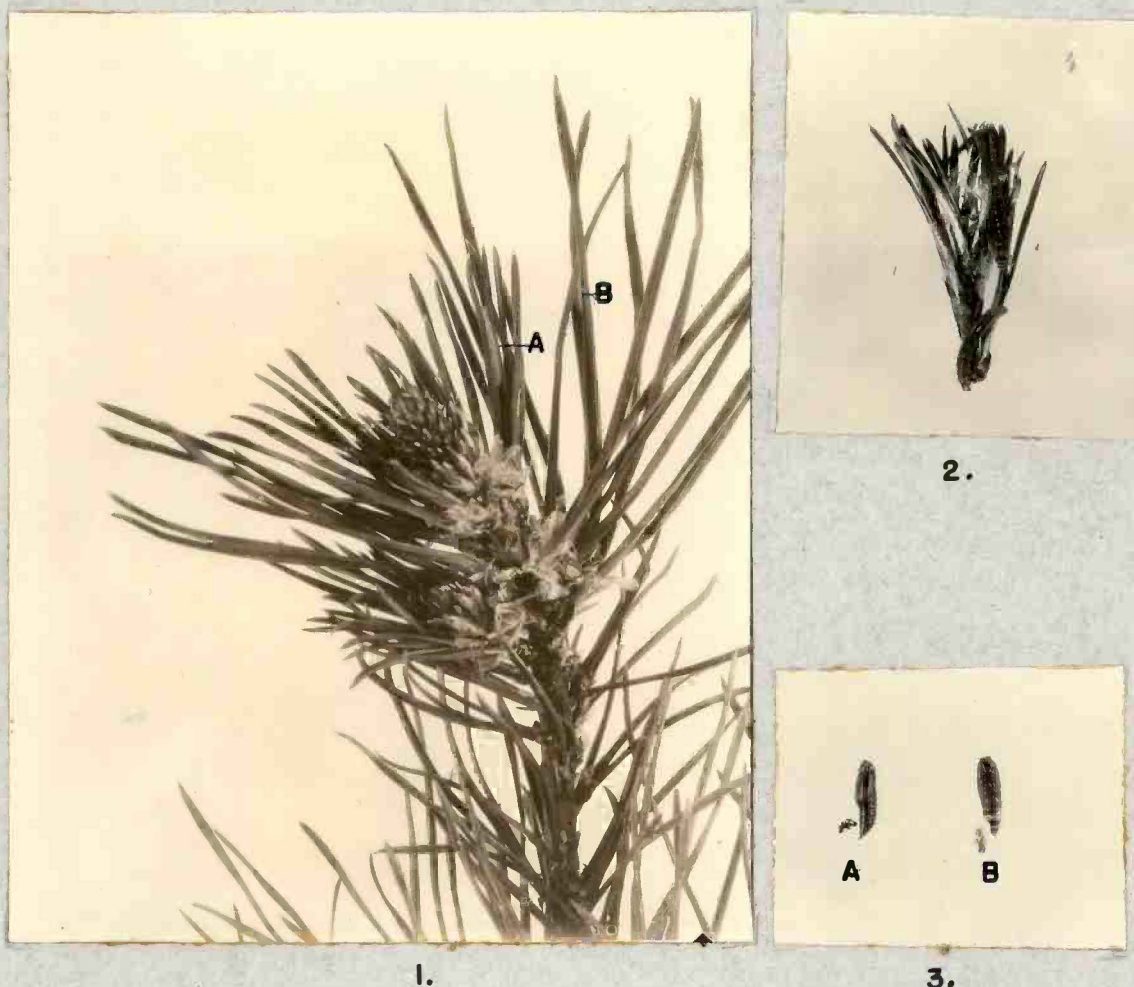
PLATE I



Argyrotaenia citrana (Ferrald) and attack on new growth of Monterey pine. A, - Empty pupa case still attached to silk webbing. B, Natural position of pupa with outer silk webbing removed. C, Adult female resting on foliage. D, Adult male. E, Fifth instar larva in natural position under silk webbing.

Photo by J.E. Patterson

PLATE II



Argyrotaenia citrana (Fernald) 1. Egg masses on shoot of Monterey pine; A, Egg mass of 25 eggs laid between two needles; B, Egg mass on single needle. 2. Mature fifth instar larvae and characteristic positions on small shoot of Monterey Pine. 3. Pupae; A, Lateral view showing cast skin on the left; B, Dorsal view, showing part of silk cocoon.

Photos by the author
Slightly enlarged.